

Nutrient Digest

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BIOCHAR: A SOIL AMENDMENT WORTH CONSIDERING

By Jim Ippolito, Rick Lentz, and Jeff Novak—USDA ARS

Biochar is a fine-grained, carbon enriched product created when biomass (e.g. wood waste, manures) is burned at relatively low temperatures (less than 1300°F) and under an anoxic (lack of oxygen) atmosphere. The process itself is called pyrolysis and is similar to the production of charcoal, yet the intent is generally to create biofuel with the concomitant production of the secondary product, biochar.

Benefits of biochar addition to soils are recognized. Amazonian dark earth soils, also known as terra preta, are charcoal-enriched soils containing a high nutrient content from reduced leaching, likely a response of human-induced biochar accumulation. These soils, dating to between 450 BC and 950 AD, are unique to the

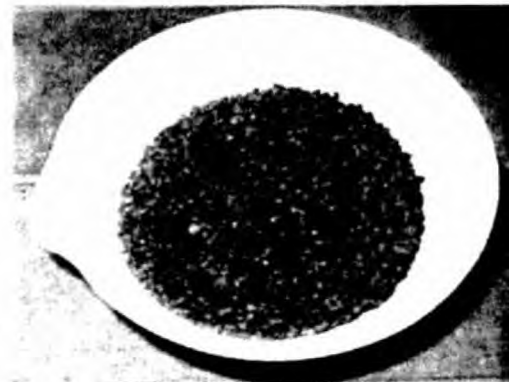


Figure 1. Biochar product

Continued on page 2

HIGHLIGHTS OF THE 2009 ANNUAL AGRONOMY MEETINGS IN PITTSBURGH

By Amber Moore—UI

At the 2009 International Annual Agronomy Society Association meetings held in November in Pittsburgh, PA, a wide variety of information was presented, with key topics including conservation tillage, biochar, ethanol production, manure applications, greenhouse gas emissions, slow-release fertilizers, organic cropping systems, and precision agriculture, just to name a few. Presentation abstracts can be accessed at <https://www.acsmeetings.org/home>. Listed below are just a few of the presentations that caught my eye.

Crop Adviser Institute (CAI) – www.cai.iastate.edu – This website

from Iowa State University has interactive computer-based learning modules for the continuing education of agricultural professionals.

The Manure Value Calculator – Developed at the University of Minnesota. Includes values for dairy manure, compost, and lagoon water applications. Designed for Minnesota growing conditions, but can still provide a ballpark estimate for Idaho producers and growers. Download excel file from the http://www.apec.umn.edu/faculty/wlazarus/interests_manureworth.html.

"Tillage-induced stratification of soil phosphorus forms" – Cade-Menun et al., Saskatoon, Canada – Bottom line – Increased available P

was found at the surface layer for no-till soils in comparison to tilled soils, resulting in increased potential of P loss in runoff.

"Using manure from cattle fed dried distillers' grain (DDG) as fertilizer: Effect on nutrient accumulation in soil and uptake by barley forage" – Hao et al., Saskatoon, Canada – Bottom line – DDG manure application resulted in higher soil total phosphorus and soil available phosphorus than soils receiving manure from typical barley grain diet, yet had no effect on phosphorus or nitrogen concentration of the barley plant tissue. In fact, soil available phosphorus

Continued on page 7



Biochar: A Soil Amendment Worth Considering continued from pg. 1



Figure 2. Pecan-shell feedstock before pyrolysis

Amazon region, as most tropical soils are highly weathered and thus generally infertile.

Scientists are now attempting to reproduce this technology by using biochar-type products as soils supplements. Increases in crop yield from applied biochar have been observed in tropical soils, likely due to biochar's ability to help soils retain nutrients and increase water holding capacity. Research by the newly formed USDA-Agricultural Research Service's National Biochar Initiative will evaluate applied biochar in soils across the US. Many questions remain to successfully use this technology. Can biochar improve the soil fertility of soils such as those that are highly weathered, calcareous, or eroded? Does biochar improve soil physical properties like water holding capacity? Can biochar supply critical plant nutrients that increase crop yields? Does biochar increase soil C storage that can reduce atmospheric carbon dioxide? Preliminary results are varied and depend on soil type, biochar characteristics, and crop

grown.

Scientists at the USDA-ARS in Florence, SC have found that a 2% biochar application (approximately 40 to 44 tons/ac) can increase soil water holding capacity of silt loam soils such as those found in Idaho. This suggests that more water is available to the plant for a longer period of time. Reduced nutrient leaching on biochar amended soils is currently being investigated by ARS scientists in South Carolina and Idaho. First-year results at the USDA ARS station in Kimberly, Idaho indicated that applying 10 tons/acre of biochar increased soil carbon concentrations and available Mn relative to controls, and



Figure 3. Pyrolyzer used to make biochar

either had no effect or decreased emission of greenhouse gases compared to controls. Biochar also interacted positively with manure to increase availability of soil N, P, and Zn. In another Kimberly study, 1 and 2% biochar (equivalent to 2 and 4 tons/acre) was added to an

eroded calcareous soil to evaluate changes in soil properties and plant nutrient uptake by a bean crop. The effect of the biochar applications on nutrient uptake in this study was minimal. Results of a separate, four-month incubation study suggested that biochar application (up to 10% by weight) to eroded calcareous soil can decrease nitrate-nitrogen concentrations and increase plant-available Fe, Mn, Ni, and Zn. A marked increase in soil organic carbon content was observed, as was expected with rate of applied biochar.

Increasing carbon storage in soil over the long-term should be achievable, as the mean residence time of biochar has been estimated at a few hundred to several thousand years. The biochar carbon stored in soils can help offset global carbon dioxide emissions. More importantly, ARS scientists are showing that some applied biochar can reduce soil nitrous oxide emissions and increase methane uptake from soils. Nitrous oxide and methane trap 310 and 20 times more atmospheric heat as compared to carbon dioxide. In the future, producers may also benefit economically when using biochar via the trading of carbon credits.

For more information, contact Jim Ippolito at 208-423-6524, or jim.ippolito@ars.usda.gov; Rick Lentz at 208-423-6531, or rick.lentz@ars.usda.gov; Jeff Novak at 843-669-5203 x110, or jeff.novak@ars.usda.gov.

EVALUATING AMMONIA, METHANE, AND NITROUS OXIDE EMISSIONS FROM AN IDAHO OPEN LOT DAIRY

PAGE 3

By April Leytem—USDA-ARS

Concentrated animal feeding operations (CAFOs) emit trace gases such as ammonia (NH₃), methane (CH₄), and nitrous oxide (N₂O) to the atmosphere. Ammonia can combine with other elements in the air to create fine particulate matter that can affect livestock and human health, while CH₄ and N₂O are potent greenhouse gases. The implementation of air quality regulations in livestock-producing states increases the need for accurate on-farm determination of emission rates that reflect the range of animal production facilities and climatic conditions that exist in the U.S.

Within the state of Idaho, the number of dairy cows has increased by approximately 80% in the last decade, with the majority of these facilities located in southern Idaho. In order to evaluate the potential air quality impacts of these facilities, baseline data from dairies in the region are necessary. To address this issue, we measured NH₃, CH₄, and N₂O concentrations over the pens and lagoon of a 700 cow open lot dairy using open-path Fourier transform infrared spectrometry. Concentrations were measured for one or two days at each location during January, March, June, and September in order to determine both daily and seasonal variations in emissions.

Median NH₃ concentrations were between 0.14 to 0.39 ppmv (parts per million by volume of air) over the pens and 0.04 to 0.17 ppmv over the lagoon, with con-

centrations tending to be lower in January. Median CH₄ concentrations were between 2.07 to 2.80 over the pens and 1.87 to 2.15 ppmv over the lagoon. Average N₂O concentrations were between 0.31 to 0.33 ppmv for all areas, which were similar to global background N₂O concentrations.

We used current modeling techniques to determine the emissions of NH₃ and CH₄ from the pen and lagoon areas. The combined ammonia emissions from the pen and lagoon areas were estimated to be 0.08, 0.55, 0.43, and 0.33 lbs NH₃ per cow per day for January, March, June, and September, respectively, and methane emissions were 0.76, 1.21, 0.47, and 0.43 lbs CH₄ per cow per day for the same months. The pens contributed the greatest amount of both NH₃ and CH₄ emissions as illustrated in Table 1. Assuming this limited monitoring was representative of the entire year, annual emissions from the pens and lagoon were 127 lbs NH₃ per cow and 262 lbs CH₄ per cow. These emission rates were similar to the limited number of comparable studies that have been published, however, more extensive monitoring is needed to better quantify variations in emissions throughout the year and among locations. We are continuing to conduct research on additional dairies for longer periods of time in order to better understand the effects of climatic variation and management practices on emissions rates. *For more information contact April Leytem, (208) 423-6530, or april.leytem@ars.usda.gov.*

Table 1. Estimated emission rates of methane and ammonia from the pen and lagoon areas of a 700 cow dairy using the WindTrax model.

Location	Average Emission Rates			
	January	March	June	September
Ammonia	lbs day ⁻¹			
Pens	53	379	265	214
Lagoon	4	9	35	15
Total	57	388	300	229
Total per cow	0.08	0.55	0.43	0.33
Methane				
Pens	500	818	256	258
Lagoon	29	26	71	44
Total	529	844	327	302
Total per cow	0.76	1.21	0.47	0.43

BIOPLASTICS, BIOGAS, AND BEYOND

By Rocky Briones, Erik Coats, and
Armando McDonald—UI

What's in your cow's poop? Different things for different people: for many livestock producers, it's mainly a waste issue and often a source of neighbor complaints. And though farmers have long recognized manure's benefits as a soil conditioner, the increasing scale of many modern livestock operations is resulting in over-application of manure-derived nutrients in the surrounding soils.

The energy value in manure is inherent: it is a material that has already partly yielded its energy (methane) content through enteric fermentation (the microbial process that goes on inside the animals' gut). Subjecting it to further anaerobic digestion releases and captures the rest of the methane gas produced by complex microbial processes. In the United States, natural gas consumption comprises 24% of total energy consumption. This country currently imports between 13% and 16% of its natural gas requirements. In theory, over half of our natural gas imports could be replaced by manure-derived biogas based on current manure production rates, if all manure was an-

aerobically digested. It is well within the realm of possibility to further boost biogas production by supplementing manure with other agricultural wastes, with the aim of eventually replacing all our natural gas imports.

Even with this promising outlook for agriculturally-derived biogas, there is still too little incentive for producers to invest in anaerobic digestion. Energy market realities (such as the low price of natural gas), high investment costs, and difficulties in handling feedstock of variable nature have blocked the progression of manure-derived biogas. With these and a host of other challenges associated with treating large volumes of manure from large livestock operations, it takes a radical shift to begin viewing manure as a resource rather than as a waste stream.

Erik Coats (UI Civil Engineering), Armando McDonald (UI Forest Products) and Aurelio Briones (UI Soils and Land Resources) are seeking ways to diversify the high value products that can be derived from cow manure. One promising route for processing this resource is high value plastics. As with biogas, bioplastics require the action of microbes to synthesize them, and based on current

production technologies, these poly-hydroxyalkanoates (PHA), are four to nine times more expensive than other synthetic plastics. This is a major obstacle toward their more widespread use. Coats, McDonald, and Briones plan to couple PHA production with anaerobic digestion in a process that greatly increases the end product value of processed manure. Intense research at UI will ultimately determine process cost effectiveness and competitiveness.

Biogas and bioplastics are only part of the research efforts at UI. The highly lignified end product (after extracting biogas and PHA) of this process is also being studied as starting material for other high value products such as resins, thermoplastics, biofuels, and biochar. The nature of this type of refining process requires a multidisciplinary effort, and the team at UI, composed of engineers, chemists and microbiologists, is just the right combination to get this job done. The research group at UI faces many challenges before their efforts yield marketable end products, but it is becoming clear that cow manure may one day be a more valuable resource. *For more information contact Rocky Briones: (208) 885-0136, or abriones@uidaho.edu.*

Idaho Nutrient Management Conference scheduled for March 9th in Shoshone, Idaho

You are invited to attend the Idaho Nutrient Management Conference on March 9th in Shoshone, Idaho. The conference will go from 8:00 a.m. to 4:30 p.m. at the Lincoln County Community Center. Presenters from the University of Idaho, USDA ARS Kimberly, NRCS, EPA, ISDA, and DEQ will provide information on new research information and updated regulations on nutrient management in Southern Idaho. Certified crop advisor (CCA) credits will be available.

For more information, contact Amber Moore at 208-736-3629.

SEED BANDED NITROGEN

PAGE 5

By Brad Brown—UI

Urea is the most common dry nitrogen (N) fertilizer used for southern Idaho crops. It is typically the cheapest of the dry N sources per unit of N and has the highest N analysis (46% N). While urea is the workhorse of the N fertilizers applied for many crops, it can be problematic depending on the application method and timing. Most importantly, only limited amounts of urea N can be placed with the planted seed, since urea can slow or prevent germination. Recently developed slow release N formulations provide alternatives to urea-seed banding. We compared various combinations of seed-banded urea or ESN slow release fertilizer with support from the Idaho Wheat Commission. Seed banded N rates were balanced with preplant broadcast urea to provide a total of 80 lb N/A, except for an untreated control. The banded treatments were placed with the winter wheat seed using a double-disk

planter with seven inch row spacing. The wheat was furrow irrigated

Urea banded with winter wheat seed reduced stands with as little as 20 lb of urea N per acre (Figure 4). Excessive urea banded with seed reduced stands, delayed germination, and reduced both plant height and yield. Figure 1 shows 80 lb of N/A banded with the seed as urea (left) or ESN (right), and an intermediate treatment of 20 lb urea N/A banded with seed and 60 lb urea N/A broadcast preplant (center). The slow release N affected stands somewhat at the 80 lb rate but not enough to affect yield, which was 35 bu/A higher than with the seed banded urea at the 80 lb rate for this late planted wheat. Yield differences are shown in Figure 6. The yield decrease with seed banded urea is not only due to poorer stands, as stands in some cases were not different by March. Slower emerging wheat performed similar to late planted wheat that matured later during hotter, less favor-

able conditions during grain fill.

The damage from seed banded urea appeared to be dependent on planting dates. Figure 5 shows the damage in November planted wheat with excessive banded urea N, but at least there were surviving plants and some production. There were so few surviving plants of early October planted wheat with banded urea at the 80lb rate that it wasn't even harvested. Cooler temperatures with later plantings ameliorate the effects of seed banded urea, due likely to slower rates of urea hydrolysis to $\text{NH}_4\text{-N}$.

We discovered other advantages with a slow release N relative to urea. Note the more uniform color and height of the wheat receiving seed banded ESN. The outside planted rows are not as washed out with banded ESN as they are with either banded urea or a combination of seed banded and preplant broadcast urea. Also, the middle rows are darker

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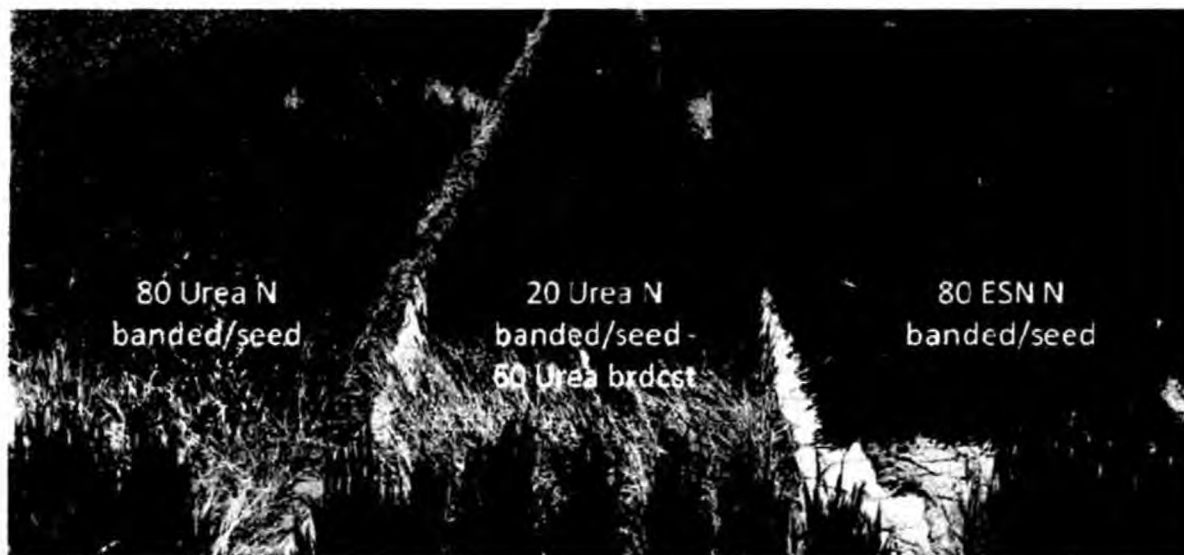


Figure 4. Winter wheat plots in 2008 at Parma treated with seed banded N or broadcast urea. The center strip also received 60 lb N/A as broadcast urea.

using conventional urea, indicating considerable movement of soluble and mobile N with the irrigation wetting front to the bed center. The slow release N was not flushed to bed centers as easily as urea providing more uniform N availability across the bed.

The seed banded N distributed among narrow (7") rows would

be less damaging than if the same N rate per acre were banded with seed in wider rows. The N/A rate is probably not as critical as the amount of N per linear foot of row.

For example, seed banded N in 14" rows at the same per acre N rate would deliver twice the N per linear foot of row as with 7" rows.

Consequently, even lower seed

banded N can be tolerated in wider spaced rows than in our study.

Slow release N such as ESN can be effective N fertilizers banded with seed at low to moderate amounts depending on the row spacing.

For more information contact Brad Brown: (208) 722-6701, or bradb@uidaho.edu.

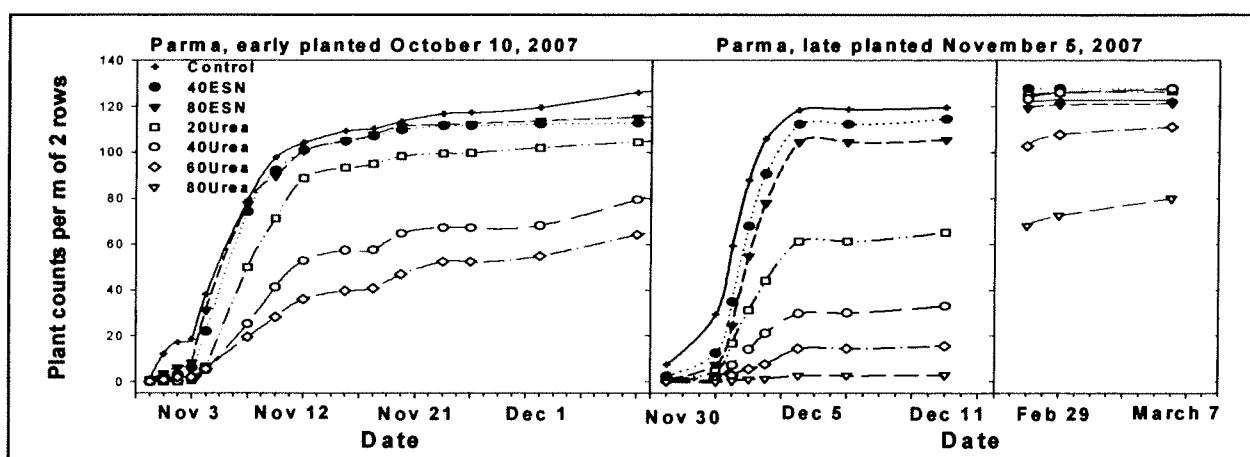


Figure 5. Winter wheat emergence (plant counts) as affected by seed banded urea and ESN in early and late plantings. For late planted wheat, note that final stands for seed-banded urea (open symbols) were not achieved until March.

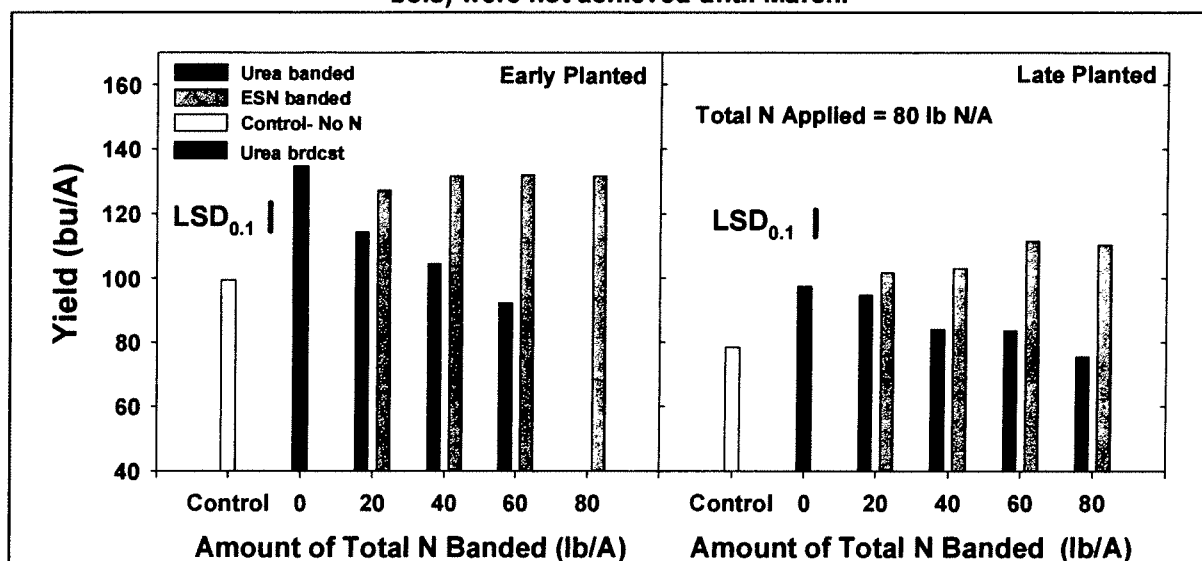


Figure 6. Winter wheat yield as affected by urea broadcast (0 banded) and increasing amounts of the total N banded with seed as either urea or ESN. Note there is no yield for 80 lb urea N/A banded with seed for the early planting.

2009 Annual Agronomy Meetings, continued from pg. 1

increased two-fold on DDG manure treated soils compared to barley grain manure treated soils, increasing the risk of P offsite transport.

"Organic no-tillage winter rye-soybean systems: Agronomic, Economic, and Environmental assessment." Bernstein et al., University of Wisconsin. Bottom line – Greater weed control and environmental benefits of no-till system were offset by reduced short-term productivity and profitability.

"Biochar effects on fertilizer N and P availability in soil", Agudelo et al. Kansas State University – Bottom line – Application of biochar at

rates up to 20 g/kg (equivalent to 39 tons/acre) in an incubation study had minimal effects on availability of N and P fertilizer on two Kansas soils.

"Broiler litter stacking reduces hormone concentrations" Cabrera et al., University of Georgia. Bottom line – Concentrations of testosterone, estradiol, and estrone were reduced by as much as 50% during four weeks of stacking (piling litter and placing in a covered stackhouse for several weeks, a standard practice for poultry producers in Georgia). Maximum temperatures achieved during stacking were 60 to 70°C.

"Effect of temperature and soil

type on ammonia volatilization from slow-release nitrogen fertilizers" University of Florida. Bottom line – Volatilization increases as proportion of urea in the slow release fertilizer increases.

"Dried distillers grains as a fertilizer source for corn" Nelson et al., University of Missouri. Bottom line – Corn grain yield increased 1.4 and 1.6 kg/ha for every kg/ha of DDGs applied in medium and high yielding environments, respectively. Grain yields were affected by amendments as follows: control < DDGs ≤ Anhydrous Ammonia = Polymer Coated Urea.

For more information contact Amber Moore: (208) 736-3629, or am-berm@uidaho.edu

~~~~~Upcoming Events~~~~~

Jan 8—Snake River Sugar Beet Conference at the Taylor and Shields buildings on the College of Southern Idaho campus, 315 Falls Avenue, Twin Falls. Contact Tamie Keeth, 208-736-3623

Jan 11-13—Far West Agribusiness Association (FWAA) Winter Conference at Cactus Pete's Resort & Casino in Jackpot. Member registration is \$100, non-member registration is \$200. For more information and a registration form, go to www.fwaa.org.

Jan 19—Public comment deadline for NPDES permit for Idaho CAFOs. [http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/General+NPDES+Permits/\\$FILE/idq01000_dp.pdf](http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/General+NPDES+Permits/$FILE/idq01000_dp.pdf)

Jan 20-21—UI Potato Conference at the Pond Student Union Building on the Idaho State University campus in Pocatello. For more information, contact Phil Deaton, 208-529-8376 or go to <http://www.extension.uidaho.edu/district4/Potato%20Conference/potato.html>

Jan 21—Camas/Blaine Counties Cereal/Forage School, 9:00 a.m. – 3:00 p.m. at the Prairie Kitchen in Fairfield. The cost is \$15. State Credits will be available. Contact Lauren Hunter, 208-788-5585

Feb 2—Magic Valley Cereal School, 8:30 a.m., at the Minidoka County Fairgrounds McGregor Center. The cost is \$15. Three Pesticide credits will be available. Contact Richard Garrard, 208-878-9461.

Feb 10-Mar 17—Idaho Master Composter/Recycler Program, Wednesdays 6:00 – 9:00 p.m. at the Wendell City Hall Meeting room. The cost is \$35; for students with ID, the cost is \$15. Dual and college credits, as well as continuing education credits for teachers will be available. Registration is due by February 2nd. Contact Mario de Haro Marti, 208-934-4417 or mdeharo@uidaho.edu.

Feb 16-17—Idaho Hay & Forage Conference at the Best Western Inn, Burley. Contact Rick Waitley, 208-888-0988, or rcwaitley@spro.net.

Feb 19—Magic Valley Bean School, 8:00 a.m. – 12:00 noon, at the Turf Club in Twin Falls. There is no cost. Contact Steve Hines, 208-734-9590.

Mar 9—Idaho Nutrient Management Conference, at the Lincoln County Community Center in Shoshone, Idaho. Contact Amber Moore for more information, 208 736-3629.

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